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NASA'S EARTH OBSERVING SYSTEM
DATA AND INFORMATION SYSTEM

Examples of EOS Variables as compared to the UMM-Var Data Model

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Objective / Approach

- **Objective:** Verify the completeness of the latest UMM-Var Data Model.
- **Approach:**
- We have taken each of the DAAC provided the Use Cases in turn, and provided some initial analysis here.
- We have taken several EOS examples and one CF example and sampled the variables.
- For each variable, we looked at the variable field structure and examined how science variables, auxiliary and quality variables are used typically.
- We have plugged the examples into the Variable class and analyzes how the model would support each Use Case.

Agenda

- Overview of Initial UMM-Var UML Data Model
- Analysis of Use Cases
- Walkthrough Examples

- *This meeting is meant to be an open dialogue. Slides are provided to help set the context, but that is all. We can deviate from the slides as needed.*

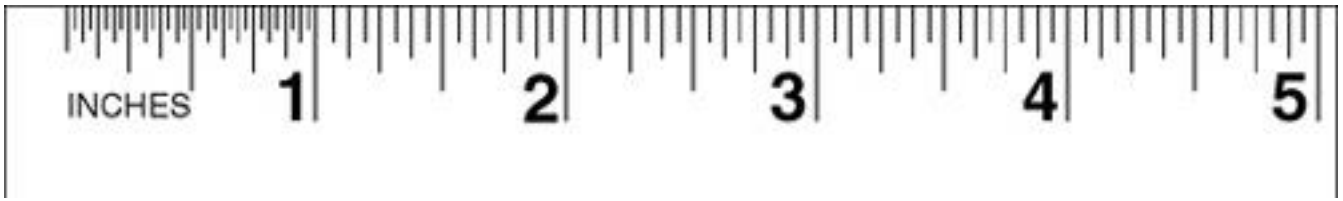
Challenge

- Common to all Variables is a set of characteristics: Name, Units, Valid Range, Data Type, Coordinate System, Fill Value, etc.
- The first thing to notice about the use of variables in these example data sets is that within a project (or collection) variables may be characterized in the same way. However, across projects (or collections) we see a range of ways of naming these characteristics

The challenge, therefore, is to model the variable characteristics across a wide sample of Data Sets.

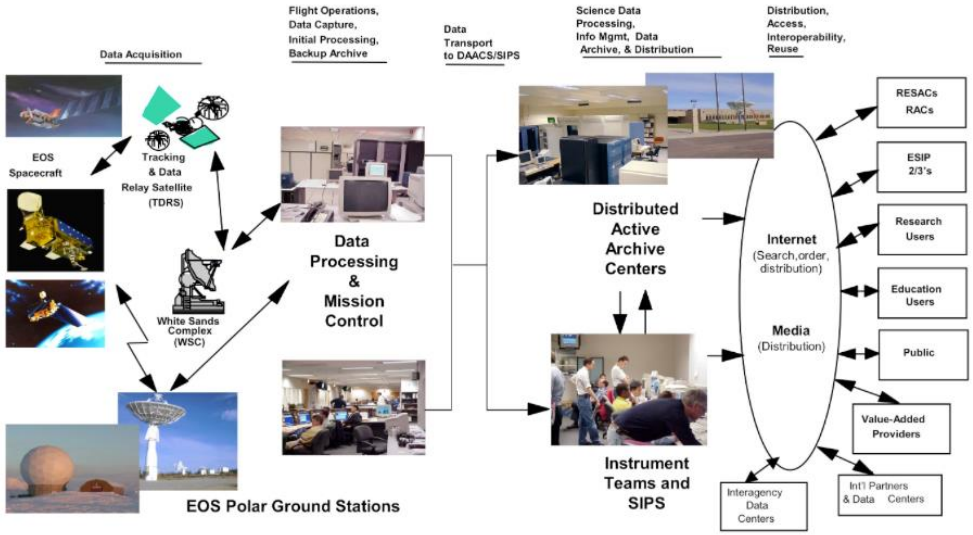
Measurement Definition

What is a Measurement? Webster's defines it as:
"the size, length, or amount of something, as established by measuring"
We can take a measurement of length using a common ruler



Variable Name: "Length"
Variable Value: "1.5"
Variable Units: "Inches"

How do we measure something using an EOS instrument?
We can take a measurement of TOA Fluxes in the following way:



Variable Name: "SW_TOA_Clear-Sky"

Variable Value: "301.8"

Variable Units: "Watts per square meter"

Measurements in general can be characterized by their: Variable Name, Variable Value, Variable Units, etc.

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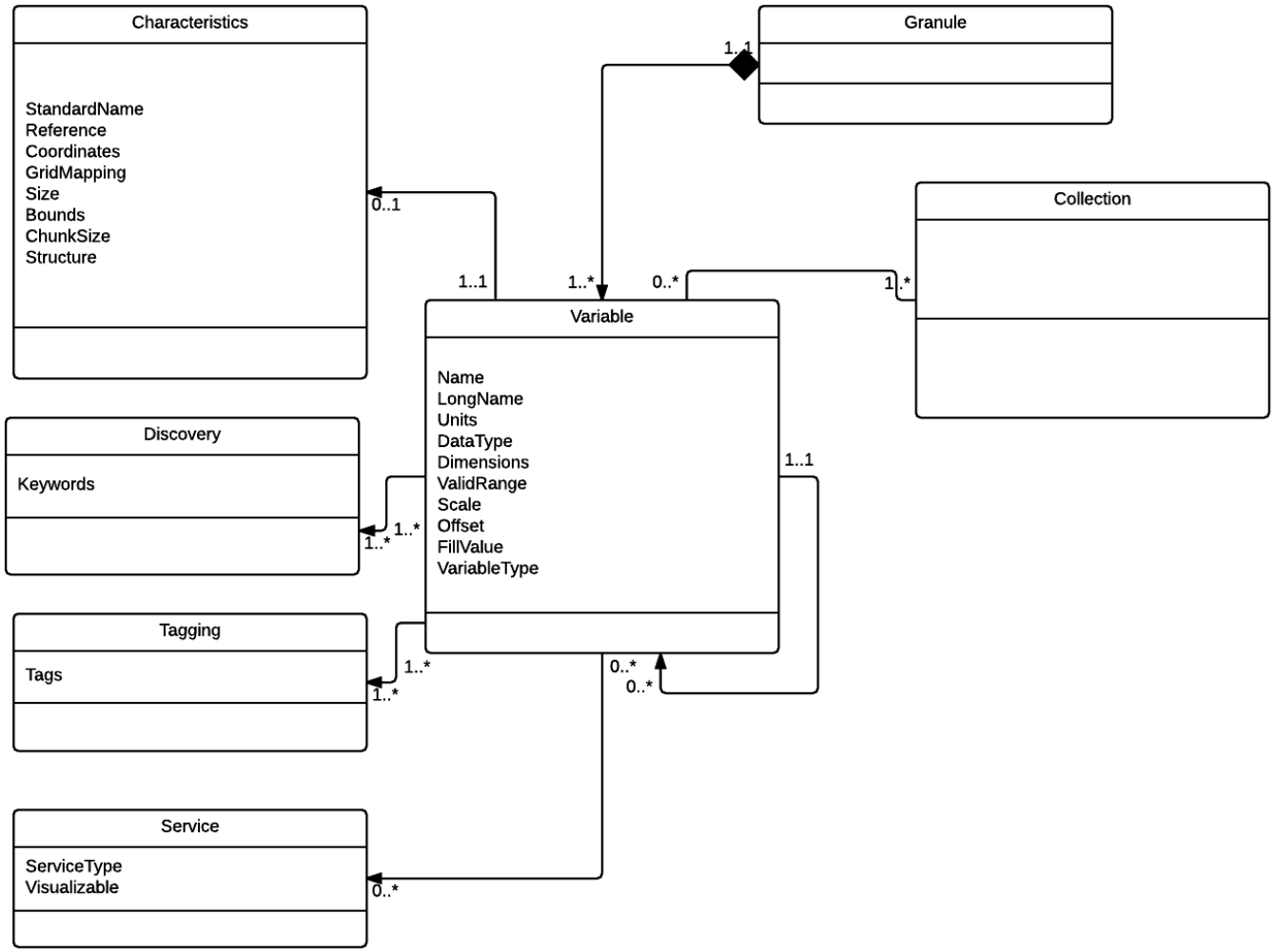
UMM-Var Data Model (revised)



Required fields and showing how our examples populate the Variable class fields*

Name	LongName	Units	Data Type	Dimensions	Valid Range	Scale	Offset	FillValue	Variable Type
sea_surface_temperature	sea_surface_subskin_temperature	kelvin	short	time=1, nj=3072, ni=4096	valid_min=-300, valid_max=4500	scale_factor=0.01	add_offset=273.15	-32768	Science
quality_level	quality level of SST pixel		byte	time=1, nj=3072, ni=4096	valid_min=0, valid_max=5			-128	Quality
LST_Day_1km	Daily daytime 1km grid Land-surface Temperature	K	short	YDim=1200, XDim=1200	valid_range=7000, -1	scale_factor=0.02		0	Science
QC_Day	Quality control for daytime LST and emmissivity		byte	YDim=1200, XDim=1200	valid_range=0, -1			undefined	Quality
CERES_SW_Filtered_Radiances_Upwards	CERES SW Filtered Radiance, Upwards	Watts per square meter per steradian	float	Records=13091, Samples=660	valid_range=-10.0, 510.0			3.0428235E38	Science
CERES_Solar_Zenith_at_Surface	CERES Solar Zenith at Surface	deg	float	Records=13091, Samples=660	valid_range=0.0, 180.0			3.0428235E38	Auxiliary
SW_TOA_Clear-Sky	1.0 degree Regional MonthObserved TOA Fluxes	Watts per square meter	float					3.0428235E38	Science
mole_fraction_of_carbon_dioxide_in_free_troposphere	mole_fraction_of_carbon_dioxide_in_free_troposphere		float	LatDim=91, LonDim=144				-9999.0	Science
CLD	Cloud Cover	oktas	short	time=1176, lat=360, lon=720	valid_range=0, 80	scale_factor=0.1		-9999	Science

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* See EOS and CF Data Set/Variables examples detailed towards the end of the slide deck (#17 on)
Indicates recommended mandatory fields for the UMM-Var class.

Initial UMM-Var Use Cases

- **Faceted Browse**
  - Scenario [a]: As a user of the Earthdata Search Client (EDSC), I can get a list of Measurement facets from the CMR.
  - Scenario [b]: As a user of the EDSC, I can click on a “Measurement” facet value and constrain the lists to the collections that match the selected Measurement and any other constraints I have selected.
- **Update Variable Associations**
  - Scenario [a]: As a CMR client, I can associate multiple variables with a collection.
  - Scenario [b]: As a CMR client, I can submit a file with multiple collections and all of the variables listed for each collection.
  - Scenario [c]: As a metadata curator, I can populate the list of valid measurements with selections from the GCMD keyword hierarchy.
- **Search Relevancy Ranking**
  - Scenario: As a search engine (CMR), I can rank collections with a high relevance ranking when one or more of the search words appear in the measurement names for the variables in the collection, as opposed to more generic fields such as the summary or references.
- **Cross-site Data Subsetting**
  - Scenario: As a subsetting GUI, I can present the variables for a given collection in a logically categorized way, such as by measurement, and further subset the data into more specific groups based on additional criteria.
- **Integrating GIBS with Web-Based Clients**
  - Scenario: As a user of a GIBS client (like EDSC, WorldView, or GloVIS), I can view granules’ browse images for a particular layer to form a request to obtain the corresponding data variables, and only those data variables pertaining to this layer. Through CMR, I can locate the granules, the corresponding data variable from which the layer was generated, and any ancillary variables that need to go along with that variable (coordinates, quality, etc.). Ideally, I can transform that information into a set of subsetting request URLs that will fetch just those data variables from the appropriate granules.
- **Browse Variables of a Collection**
  - Scenario: the user starts with a collection, and wants to know what variables it includes
- **Access variable data including ancillary variable data (extension of cross-site data subsetting use case)**
  - Scenario: the user starts with a set of variables (e.g., {<measurement type>, <vertical location>, <wavelength>, ... }, and wants to know which collections contain variables that satisfy (and may also want to know what data quality, instrument calibration, spacecraft location, etc. variables are needed to properly understand the data).

Analysis of UMM-Var Use Cases

- **Faceted Browse**
  - Scenario [a]: As a user of the Earthdata Search Client (EDSC), I can get a list of Measurement facets from the CMR.
  - Scenario [b]: As a user of the EDSC, I can click on a "Measurement" facet value and constrain the lists to the collections that match the selected Measurement and any other constraints I have selected.

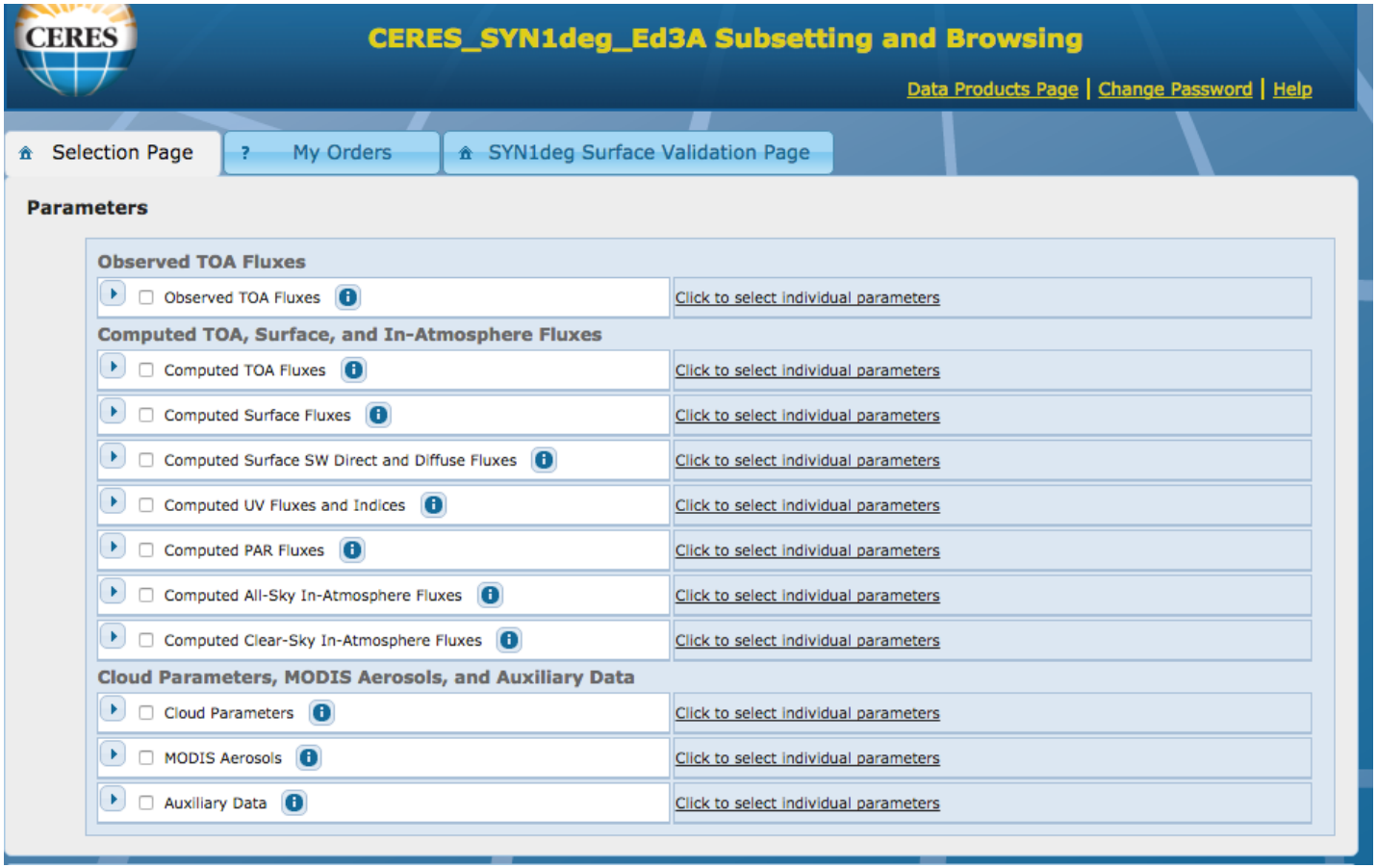
Analysis

- User knows which "facets" i.e. collections, instrument names, science variable names of interest, but needs to browse a list generated from the CMR (database).
- Via the EDSC, a user can enter the search terms via the main Search field, then can Browse Collections displayed in a list.
- Via the Browse Collections form, the user can select from science, quality or auxiliary variable names, or other field values, and further constrain the list of Collections displayed in the list.
- The proposed model will support both scenarios [a] and [b], by enabling a search of "tags", and "variable" names, and other associated fields, via the EDSC client main Search field. The capability to display and select from a dynamic list of Measurement "facet" values would need to be added.

Fields used: <Collection/ShortName>,<Platform/InstrumentName>, <Variable/Name>, <Variable/VariableType>, <Variable/Tagging/Tags>, <Variable/Discovery/Keywords>, <Granule/ShortName>

Comparison with CERES_SYN1edg_Ed3A Subsetting and Browsing Tool.

Parameters (Variables) selection pane shown here.



CERES Subsetting and Browsing tool GUI allows subsetting by Parameter, Spatial, and Temporal ranges (Parameters only shown here). Note: We now call Parameters: Variables.

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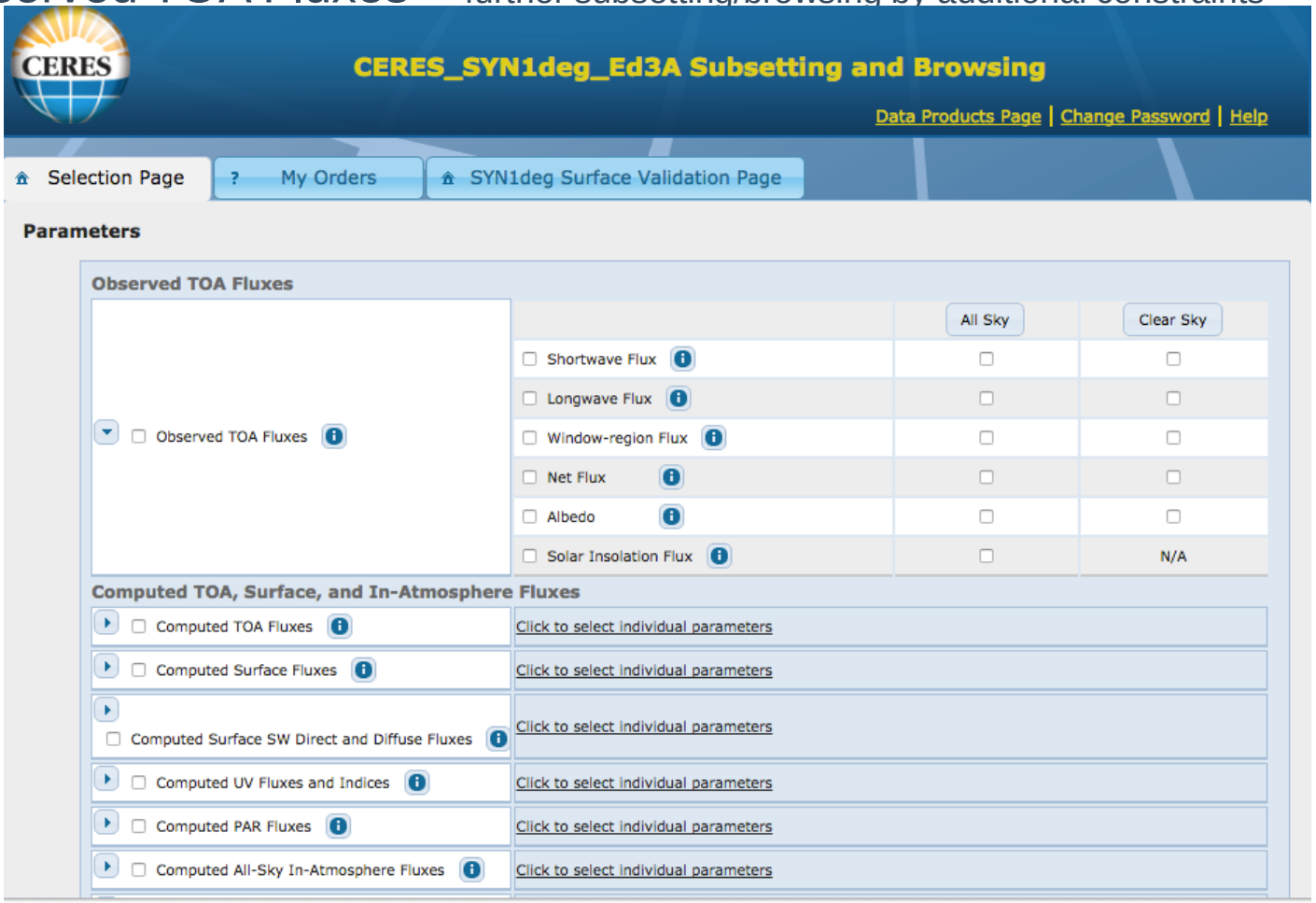
CERES_SYN1edg_Ed3A Subsetting and Browsing Tool (Selected Observed TOA Fluxes – further subsetting/browsing by additional constraints



Individual variables are exposed to the GUI, by clicking on the link, or checking the appropriate checkbox. This variable "structure" is common to all granules within this collection.

Analysis of UMM-Var Use Cases

- **Update Variable Associations**
  - Scenario [a]: As a CMR client, I can associate multiple variables with a collection.
  - Scenario [b]: As a CMR client, I can submit a file with multiple collections and all of the variables listed for each collection.
  - Scenario [c]: As a metadata curator, I can populate the list of valid measurements with selections from the GCMD keyword hierarchy.

Analysis

- Scenario [a]: In order for a CMR client, such as the MMT, to allow associations which exist between variables and collections to be persistently stored, a capability will need to be added in order to make new associations for variables to those already listed with a collection. The MMT would need to present to the metadata curator a list of variables and a method of selecting the appropriate collections in order for them to make the associations persistent.
- Scenario [b]: In order for a CMR client, such as the MMT, to submit files containing collection and variable associations, a file format for specifying these associations is required. A capability would need to be added to the MMT in order to upload files containing definitions of variables.
- Scenario [c]: In order for a metadata curator to be able to populate a list of valid measurements with selections from the GCMD keyword hierarchy, a CMR client, such as the MMT, would need to display the GCMD keyword hierarchy and the list of variables and allow the metadata curator to make associations between them.
- The proposed model will support scenarios [a], [b], and [c] by providing for the persistent storage of variables, the ability to maintain associations between variables and collections, and also the associations between variables and keywords.
- The capability to populate the list of valid measurements from a file would need to be added to the CMR client. There are alternative programmatic methods available to download the keywords, from GCMD keywords* , in order to populate the keyword field, and enable these to be brought out for display on the MMT.

Fields used: <Collection/ShortName>,<Variable/Name>, <Variable/VariableType>, <Variable/Discovery/Keywords>, <Granule/ShortName>

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* Source of keywords could be from the names defined in the GCMD Valids List, Version 8.1, : http://gcmd.nasa.gov/learn/keyword_list.html

Analysis of UMM-Var Use Cases

- **Search Relevancy Ranking**
  - Scenario: As a search engine (CMR), I can rank collections with a high relevance ranking when one or more of the search words appear in the measurement names for the variables in the collection, as opposed to more generic fields such as the summary or references.

Analysis

- Search words, either in the form of keywords or tags can be associated with variables in the collection.
- It is preferable to use keywords, since these can take advantage of controlled vocabularies, or tags*, which are uncontrolled.

- In a search, for example, the search words: “surface temperature”, can be used as a primary tagging term, and a secondary search term: “land” depending on the science data set being searched for.
- The results set from this search would rank collections associated with “land surface temperature” and highest, but will also show collections with lower ranking, such as those associated with “surface temperature”. The collections presented in the results set would be ordered in descending order of rank.
- In this scenario, “land” and “surface temperature” would be tagged to the variables in the collections to which they have associations. In our example, these tags would belong to the variables associated with the MODIS MOD11A1 collection.

Fields used: <Collection/ShortName>,<Variable/Name>, <Variable/VariableType>, <Variable/Discovery/Keywords>, <Variable/Tagging/Tags>

* Source of tags could be either from the names defined in the CSDMS Standard: http://csdms.colorado.edu/wiki/CSN_Examples, or alternatively the CF convention, http://cfconventions.org/Data/cf-standard-names/27/build/cf-standard-name-table.html (TBD).

Analysis of UMM-Var Use Cases

- **Cross-site Data Subsetting**
  - Scenario: As a subsetting GUI, I can present the variables for a given collection in a logically categorized way, such as by measurement, and further subset the data into more specific groups based on additional criteria.
- **Access variable data including ancillary variable data (extension of cross-site data subsetting use case)**
  - Scenario: the user starts with a set of variables (e.g., {<measurement type>, <vertical location>, <wavelength>, ... }, and wants to know which collections contain variables that satisfy (and may also want to know what data quality, instrument calibration, spacecraft location, etc. variables are needed to properly understand the data).

  Analysis
  - A Subsetting GUI provides a way to display variables which are associated with a collection, and also provides a method to enable the data to be further subsetted. Collections may be originated from different sites, but are brought together in the CMR. The subsetting query will search across multiple collections.
  - A Subsetting GUI provides a way to display auxiliary variables, or quality variables, which are directly related to science variables and their associated collections (either at one originating site, or across multiple sites).
  - For example, the variables could be ordered by {<measurement type>, <vertical location>, <wavelength>, ... }.
  - In order to support such grouping of variables, some key characteristics need to be surfaced in the GUI. This information is contained within the following fields: Name, LongName, Units, Valid Range, etc. A programmatic mechanism will be required to pattern match some of this information from within the CMR fields at the time of search.
  - Some information, such as instrument calibration, spacecraft location would require instrument calibration status and ephemeris metadata to be included in the search.

Fields used: <Collection/ShortName>,<Variable/Name>,<Variable/LongName>, <Variable/VariableType>, <Variable/ValidRange>, <Variable/Discovery/Keywords>, <Variable/Tagging/Tags>, <Collection/Spatial>, <Collection/Platform/Instrument>, <Granule/ShortName>

Analysis of UMM-Var Use Cases

- **Integrating GIBS with Web-Based Clients**
  - Scenario: As a user of a GIBS client (like EDSC, WorldView, or GloVIS), I can view granules' browse images for a particular layer to form a request to obtain the corresponding data variables, and only those data variables pertaining to this layer. Through CMR, I can locate the granules, the corresponding data variable from which the layer was generated, and any ancillary variables that need to go along with that variable (coordinates, quality, etc.). Ideally, I can transform that information into a set of subsetting request URLs that will fetch just those data variables from the appropriate granules.

Analysis

- A GIBS client (e.g. EDSC, WorldView, or GioVIS) may be used to display browse images for a particular layer in the data set. The client can be used to formulate a query to locate the granules, and the associated science, quality and auxiliary variables. The query can then be used to generate a subsetting request to fetch the variables (science, quality and auxiliary) associated with the selected granules.
- Programmatic methods are available to transform the granules selections, the science, quality or ancillary variables that these granules are associated with, into a subsetting request. The proposed data model supports this method of search, by virtue of the variable and granule associations.

Fields used: <Collection/ShortName>,<Variable/Name>,<Variable/LongName>, <Variable/VariableType>, <Variable/ValidRange>, <Variable/Discovery/Keywords>, <Variable/Tagging/Tags>, <Granule/ShortName>

Analysis of UMM-Var Use Cases

- **Browse Variables of a Collection**
  - Scenario: the user starts with a collection, and wants to know what variables it includes

Analysis

- Via a suitable client, a user may select a collection by name from a list of collections, and then retrieve a set of variables associated with that collection.
- The proposed model will support this scenario by virtue of the associations which exist between variables and collections.
- The capability to display that list of variables from the collection of interest would need to be added to the EDSC GUI.

Fields used: <Collection/ShortName>,<Variable/Name>,<Variable/LongName>, <Granule/ShortName>

EOS and CF Data Set/Variables

EXAMPLES

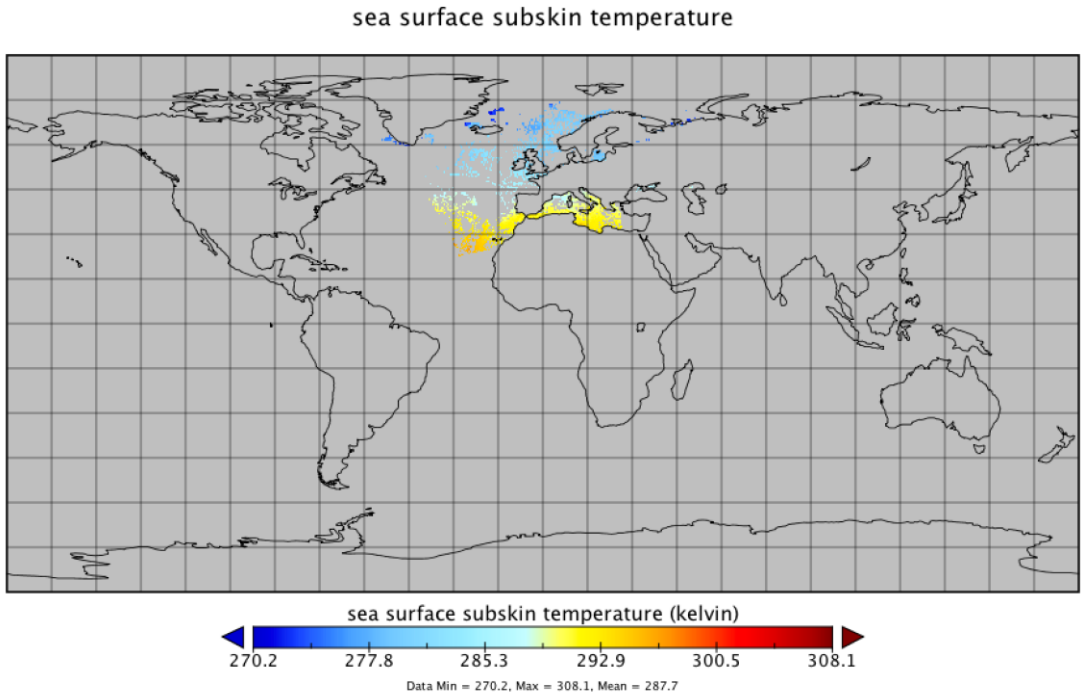
VIIRS SST NPP Data Set structure

Name	Long Name	Type
20160426130000-OSISAF-L3C_GHRSST-SSTsubskin-VIIRS_SST_NPP...	2016042613000...	Local File
adi_dtime_from_sst	time difference of ...	Geo2D
aerosol_dynamic_indicator	aerosol dynamic i...	Geo2D
dt_analysis	deviation from SST...	Geo2D
l2p_flags	L2P flags	Geo2D
lat	latitude	2D
lon	longitude	2D
or_latitude	original latitude of...	Geo2D
or_longitude	original longitude ...	Geo2D
quality_level	quality level of SST...	Geo2D
satellite_zenith_angle	satellite zenith angle	Geo2D
sea_ice_fraction	sea ice fraction	Geo2D
sea_surface_temperature	sea surface subski...	Geo2D
solar_zenith_angle	solar zenith angle	Geo2D
sources_of_adi	sources of aerosol...	Geo2D
sses_bias	SSES bias estimate	Geo2D
sses_standard_deviation	SSES standard dev...	Geo2D
sst_dtime	time difference fro...	Geo2D
wind_speed	10m wind speed	Geo2D

sea surface temperature variable

Variable "sea_surface_temperature"

```
short sea_surface_temperature(time=1, nj=3072, ni=4096);
  :_FillValue = -32768S; // short
  :long_name = "sea surface subskin temperature";
  :standard_name = "sea_surface_subskin_temperature";
  :units = "kelvin";
  :add_offset = 273.15; // double
  :scale_factor = 0.01; // double
  :valid_min = -300S; // short
  :valid_max = 4500S; // short
  :coordinates = "lon lat";
  :grid_mapping = "polar_stereographic_proj";
  :depth = "1 millimeter";
  :source = "VIIRS";
  :comment = "Temperature of the subskin of the ocean";
  :_ChunkSizes = 1, 1536, 2048; // int
```



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quality_level variable

Variable "quality_level"

```
byte quality_level(time=1, nj=3072, ni=4096);
  :_FillValue = -128B; // byte
  :long_name = "quality level of SST pixel";
  :valid_min = 0B; // byte
  :valid_max = 5B; // byte
  :flag_meanings = "no_data bad_data worst_quality low_quality acceptable_quality best_quality";
  :flag_values = 0B, 1B, 2B, 3B, 4B, 5B; // byte
  :coordinates = "lon lat";
  :grid_mapping = "polar_stereographic_proj";
  :comment = "These are the overall quality indicators and are used for all GHRSST SSTs";
  :_ChunkSizes = 1, 1536, 2048; // int
```

MOD11A1 Data Set Structure

Name	Long Name	Type
MOD11A1.A2009172.h16v05.006.2016014073638.hdf	MOD11A1.A2009172.h16v05.006....	Local File
ArchiveMetadata.0	ArchiveMetadata.0	—
CoreMetadata.0	CoreMetadata.0	—
MODIS_Grid_Daily_1km_LST	MODIS_Grid_Daily_1km_LST	—
_HDFEOS_CRS	_HDFEOS_CRS	—
Data_Fields	MODIS_Grid_Daily_1km_LST/Data_Fi...	—
Clear_day_cov	day clear-sky coverage	Geo2D
Clear_night_cov	night clear-sky coverage	Geo2D
Day_view_angl	View zenith angle of daytime Land-...	Geo2D
Day_view_time	Time of daytime Land-surface Tem...	Geo2D
Emis_31	Band 31 emissivity	Geo2D
Emis_32	Band 32 emissivity	Geo2D
LST_Day_1km	Daily daytime 1km grid Land-surfac...	Geo2D
LST_Night_1km	Daily nighttime 1km grid Land-surf...	Geo2D
Night_view_angl	View zenith angle of nighttime Land...	Geo2D
Night_view_time	Time of nighttime Land-surface Te...	Geo2D
Projection	Projection	—
QC_Day	Quality control for daytime LST and ...	Geo2D
QC_Night	Quality control for nighttime LST and...	Geo2D
XDim	x coordinate	1D
YDim	y coordinate	1D
StructMetadata.0	StructMetadata.0	—

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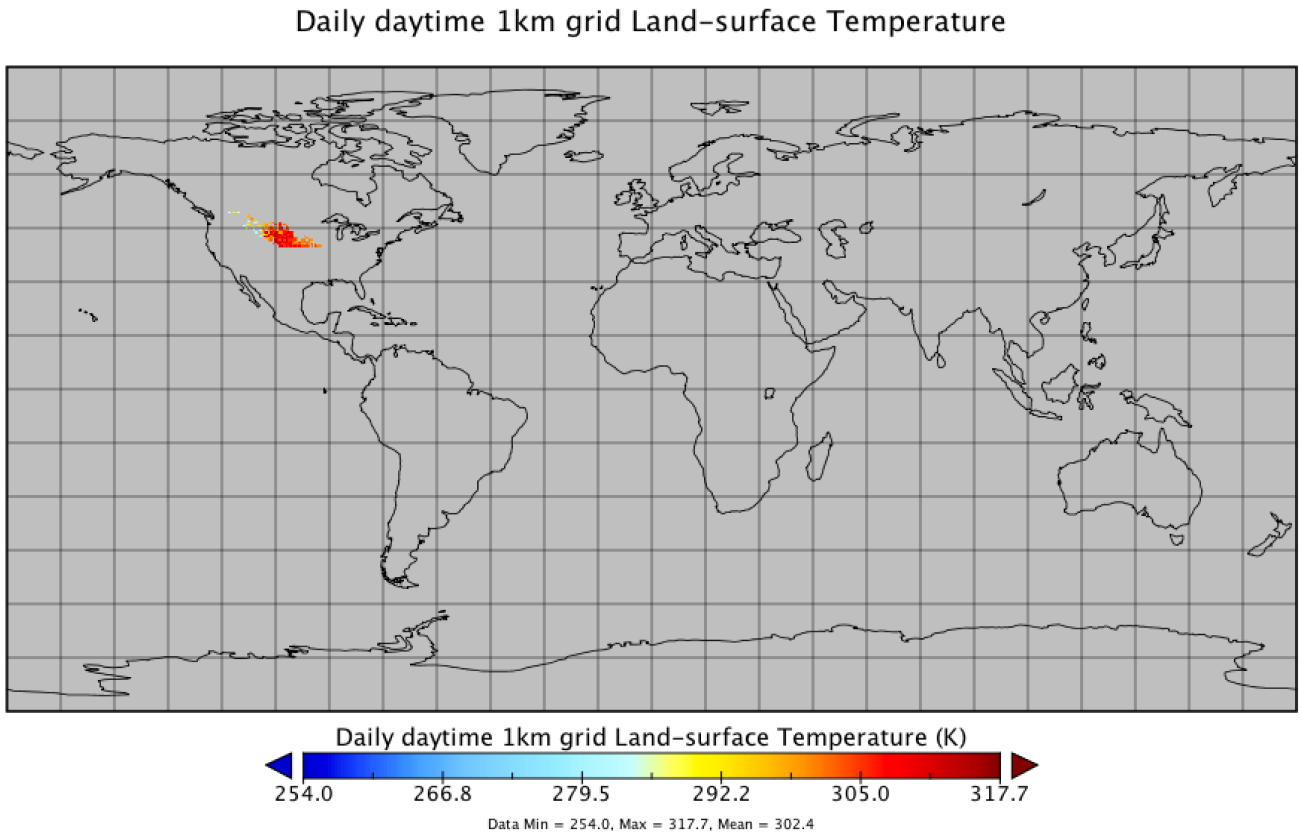
LST_Day_1km variable

Variable "LST_Day_1km"

```
short LST_Day_1km(YDim=1200, XDim=1200);
  :_Unsigned = "true";
  :long_name = "Daily daytime 1km grid Land-surface Temperature";
  :units = "K";
  :Number_Type = "uint16";
  :valid_range = 7500S, -1S; // short
  :_FillValue = 0S; // short
  :LST = "LST data * scale_factor";
  :scale_factor = 0.02; // double
  :scale_factor_err = 0.0; // double
  :add_offset_err = 0.0; // double
  :calibrated_nt = 5; // int
```



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QC_Day variable

Variable "QC_Day"

```
byte QC_Day(YDim=1200, XDim=1200);
  :_Unsigned = "true";
  :long_name = "Quality control for daytime LST and emissivity";
  :Number_Type = "uint8";
  :valid_range = 0B, -1B; // byte
```

CER_BDS_Aqua-FM3_Edition1 Data Set structure

Name	Long Name	Type
CER_BDS_Aqua-FM3_Edition1-...	CER_BDS_Aqua-FM3_Edition1-CV...	Local File
Azimuth_Position_Count	Azimuth Position Count	2D
CERES_metadata	CERES_metadata	—
CERES_Relative_Azimuth_at...	CERES Relative Azimuth at Surface	2D
CERES_Relative_Azimuth_at...	CERES Relative Azimuth at TOA - ...	2D
CERES_Solar_Zenith_at_Surf...	CERES Solar Zenith at Surface	2D
CERES_Solar_Zenith_at_TOA...	CERES Solar Zenith at TOA - Geoc...	2D
CERES_SW_Filtered_Radianc...	CERES SW Filtered Radiance, Upw...	2D
CERES_TOT_Filtered_Radian...	CERES TOT Filtered Radiance, Up...	2D
CERES_Viewing_Zenith_at_S...	CERES Viewing Zenith at Surface	2D
CERES_Viewing_Zenith_at_T...	CERES Viewing Zenith at TOA - G...	2D
CERES_WN_Filtered_Radianc...	CERES WN Filtered Radiance, Up...	2D
Clock_Angle_Rates	Clock Angle Rates	2D
Clock_Angles	Clock Angles	2D
Colatitude_of_CERES_FOV_a...	Colatitudes of CERES FOV at Surface	2D
Colatitude_of_CERES_FOV_a...	Colatitudes of CERES FOV at TOA	2D
Cone_Angle_Rates	Cone Angle Rates	2D
Cone_Angles	Cone Angles	2D
Converted_Azimuth_Angles	Converted Azimuth Angles	2D
Converted_Elevation_Angles	Converted Elevation Angles	2D
Converted_Instrument_Stat...	Converted_Instrument_Status_Data	—
Converted_Temperatures	Converted_Temperatures	—
Converted_Voltages_and_T...	Converted_Voltages_and_Torques	—
Count_Conversion_Constants	Count_Conversion_Constants	—
Count_Conversion_SW_Sam...	Count Conversion SW Sample Offs...	2D
Count_Conversion_TOT_Sa...	Count Conversion TOT Sample Of...	2D
Count_Conversion_WN_Sa...	Count Conversion WN Sample Off...	2D

CERES_SW_Filtered_Radiances_Upwards Variable

Variable "CERES_SW_Filtered_Radiances_Upwards"

```
float CERES_SW_Filtered_Radiances_Upwards(Records=13091, Samples=660);
  :long_name = "CERES SW Filtered Radiance, Upwards";
  :units = "Watts per square meter per steradian";
  :format = "32-BitFloat";
  :coordsys = "not used";
  :valid_range = -10.0f, 510.0f; // float
  :_FillValue = 3.4028235E38f; // float
```

CERES_Solar_Zenith_at_Surface

Variable "CERES_Solar_Zenith_at_Surface"

```
float CERES_Solar_Zenith_at_Surface(Records=13091, Samples=660);
  :long_name = "CERES Solar Zenith at Surface";
  :units = "deg";
  :format = "32-BitFloat";
  :coordsys = "not used";
  :valid_range = 0.0f, 180.0f; // float
  :_FillValue = 3.4028235E38f; // float
```

CERES_SYN_1km Data Set structure

CER_SYN1deg-M3Hour_Terra-Aqua-MODIS_Edition3A_302301.200906	CER_SYN1deg-M3Ho...	Local File
1.0_Degree_Regional	1\.0_Degree_Regional	—
Cloud_Layer_-_High	1\.0_Degree_Regiona...	—
Cloud_Layer_-_Low	1\.0_Degree_Regiona...	—
Cloud_Layer_-_LowerMid	1\.0_Degree_Regiona...	—
Cloud_Layer_-_UpperMid	1\.0_Degree_Regiona...	—
Constrainment_Adjustments	1\.0_Degree_Regiona...	—
MODIS_Aerosol_Optical_Depth	1\.0_Degree_Regiona...	—
Number_of_Hourboxes	1\.0_Degree_Regiona...	—
Observed_TOA_Fluxes	1\.0_Degree_Regiona...	—
LW_TOA_Clear-Sky	1.0 Degree Regional ...	2D
LW_TOA_Total-Sky	1.0 Degree Regional ...	2D
SW_TOA_Clear-Sky	1.0 Degree Regional ...	2D
SW_TOA_Total-Sky	1.0 Degree Regional ...	2D
WN_TOA_Clear-Sky	1.0 Degree Regional ...	2D
WN_TOA_Total-Sky	1.0 Degree Regional ...	2D
PAR_Fluxes	1\.0_Degree_Regiona...	—
Pristine-Sky_SW_MultiStream_Correction	1\.0_Degree_Regiona...	—
Satellite_Emulated_WN_TOA_Fluxes	1\.0_Degree_Regiona...	—
Stowe-Ignatov_Aerosol_Optical_Depth	1\.0_Degree_Regiona...	—
Surface_SW_Fluxes	1\.0_Degree_Regiona...	—
Time_And_Position	1\.0_Degree_Regiona...	—
TOA_Flux_Error	1\.0_Degree_Regiona...	—
Tuned_ClearSky_Flux_Profiles	1\.0_Degree_Regiona...	—

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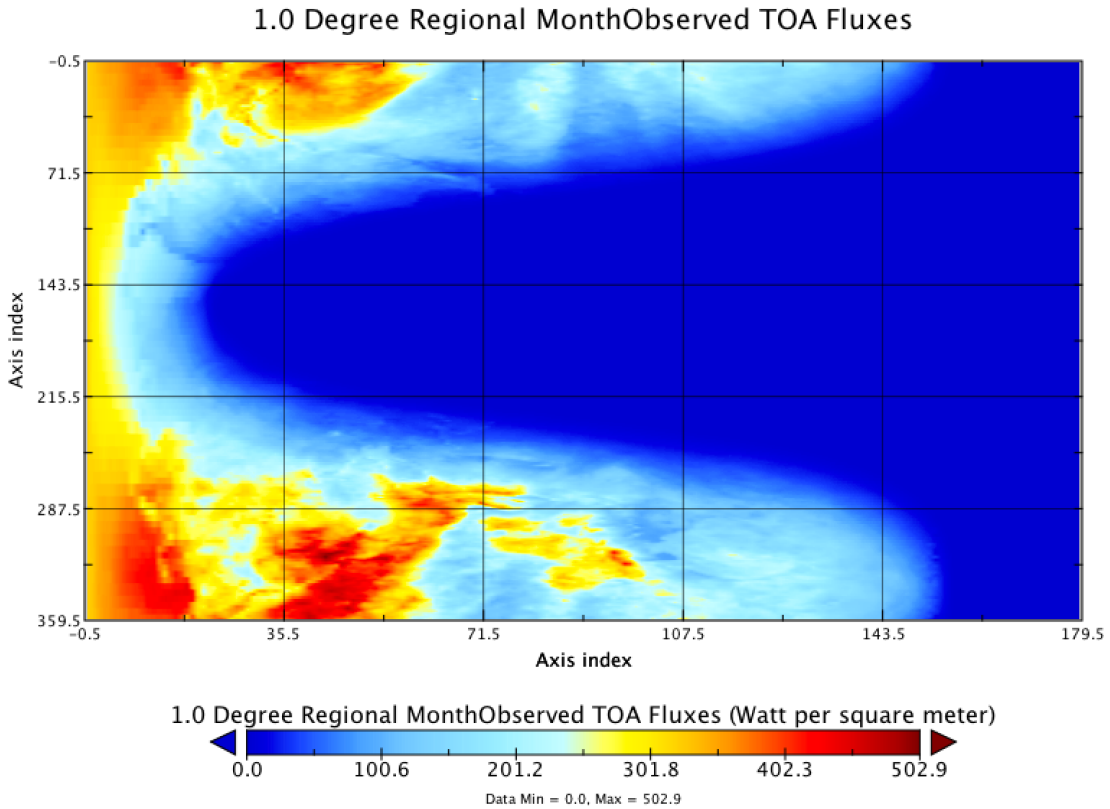
SW_TOA_Clear-Sky variable structure

Variable "SW_TOA_Clear-Sky"

```
float SW_TOA_Clear-Sky(Mean_&_Stdev=2, Synoptic_Hours_(1,4,7,10,13,16,19,22)=8, 1.0_deg._regional_colat._zones=180, 1.0_deg._regional_long._zones=360);
  :_FillValue = 3.4028235E38f; // float
  :long_name = "1.0 Degree Regional MonthObserved TOA Fluxes";
  :units = "Watt per square meter";
```



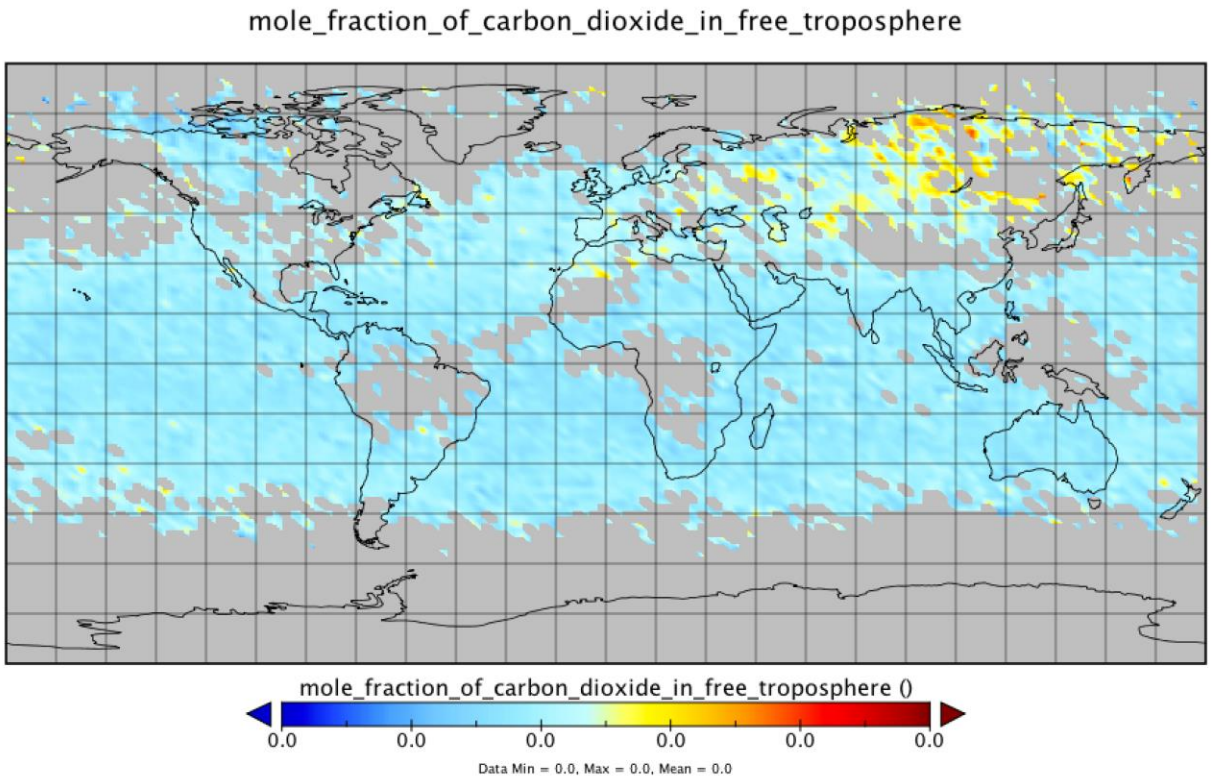
AIRS.2012.02.09.L3.CO2Std008 Data Set structure

Name	Long Name	Type
AIRS.2012.02.09.L3.CO2Std008.v5.9.14.0.X12089141044.hdf	AIRS.2012.02.09....	Local File
CO2	CO2	—
Data_Fields	CO2/Data_Fields	—
Latitude	Latitude	2D
Longitude	Longitude	2D
mole_fraction_of_carbon_dioxide_in_free_troposphere	mole_fraction_of_c...	Geo2D
mole_fraction_of_carbon_dioxide_in_free_troposphere_count	mole_fraction_of_c...	Geo2D
mole_fraction_of_carbon_dioxide_in_free_troposphere_sdev	mole_fraction_of_c...	Geo2D
Grid_Attributes	CO2/Grid_Attributes	—

mole_fraction_of_carbon_dioxide_in_free_troposphere variable

Variable "mole_fraction_of_carbon_dioxide_in_free_troposphere"

```
float mole_fraction_of_carbon_dioxide_in_free_troposphere(LatDim=91, LonDim=144);
  :_FillValue = -9999.0f; // float
```



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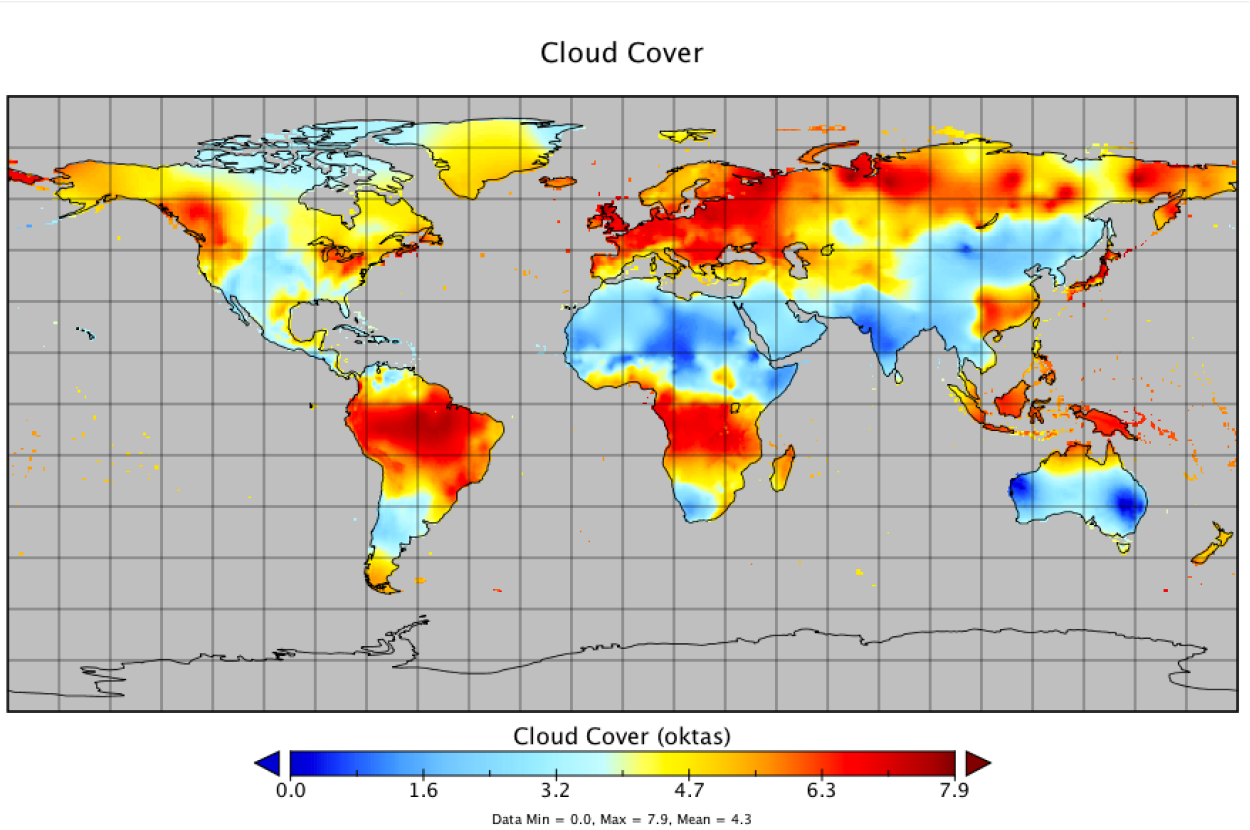
ORNL DAAC THREDDS Cloud Cover Data Set structure

Name	Long Name	Type
climate_1901_1998_CLD.nc4	climate_1901_1998_CLD.nc4	Remote File
CLD	Cloud Cover	Geo2D
lat	latitude	1D
lat_bnds	lat_bnds	2D
lon	longitude	1D
lon_bnds	lon_bnds	2D
time	month	1D

CLD variable

Variable "CLD"

```
short CLD(time=1176, lat=360, lon=720);
  :_CoordinateAxes = "time lat lon ";
  :long_name = "Cloud Cover";
  :units = "oktas";
  :valid_range = 0, 80; // int
  :scale_factor = 0.1; // double
  :_FillValue = -9999S; // short
  :_ChunkSize = 1, 360, 720; // int
```



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Raytheon

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